(12) UK Patent Application (19) GB (11) 2 373 770 (13) A

(43) Date of A Publication 02.10.2002

(21) Application No 0108063.9

(22) Date of Filing 30.03.2001

(51) INT CL[7]
B62K 15/00

(52) UK CL (Edition T)
B7E ECF E102

(56) Documents Cited
GB 2260520 A
EP 0965517 A2
WO 1999/038759 A1
DE 4313832 A

(58) Field of Search
UK CL (Edition S) B7E ECF EDTX
INT CL[7] B62K 15/00
ONLINE WPI EPODOC JAPIO

(71) Applicant(s)
ATB Sales Limited
(Incorporated in the United Kingdom)
Whitworth Road, ST LEONARDS-ON-SEA,
East Sussex, TN37 7PZ, United Kingdom

(72) Inventor(s)
Jon Frank Ross Whyte

(74) Agent and/or Address for Service
Dr Walther Wolff & Co
6 Buckingham Gate, LONDON, SW1E 6JP,
United Kingdom

(54) Abstract Title
Folding bicycle

(57) The bicycle includes a frame (10), a swing arm (21) carrying a rear wheel (20) and a two-stage transmission for transmitting motive force applied by way of a pedal drive assembly (14), to the rear wheel (20) for rotation thereof. The swing arm (21) is connected with the frame (10) at a junction of the stages of the transmission to be pivotable relative to the frame through a given range of suspension travel and to additionally be pivotable, after release of a coupling at, for example, a spring and damper unit (28), beyond that range to enable folding of the swing arm and rear wheel relative to the frame. The two-stage transmission can include a speed change system (33, 34) at the junction and a system (29) at the assembly (14) to allow the bicycle to reach higher travel speeds without obliging use of a larger-diameter rear wheel or transmission chainwheel.

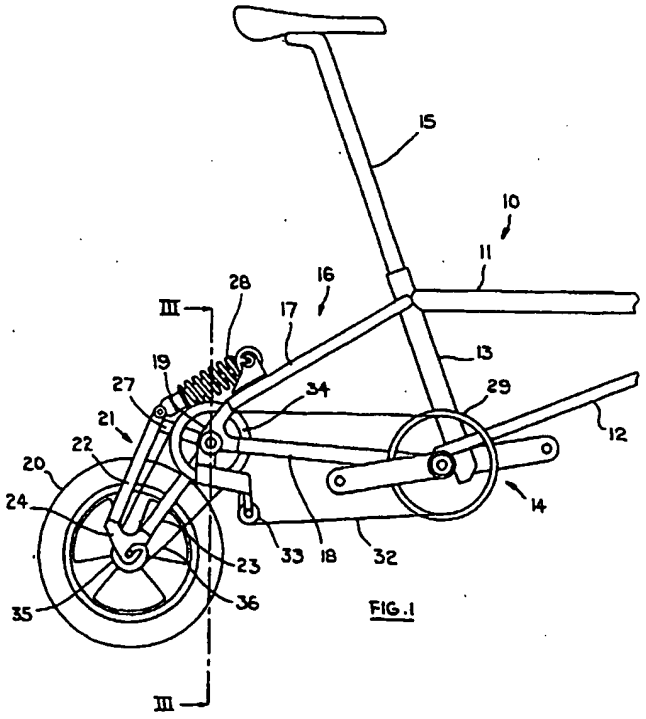

FIG.1

GB 2 373 770 A

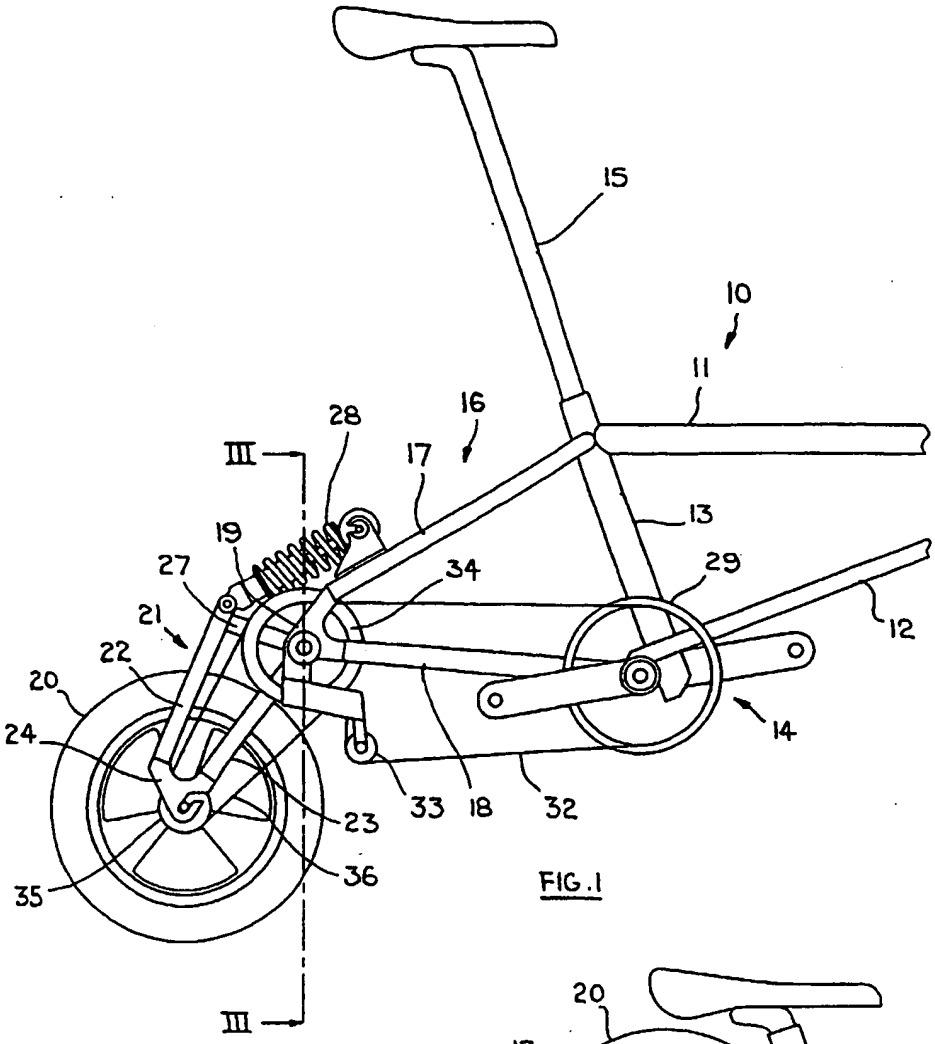

FIG.1

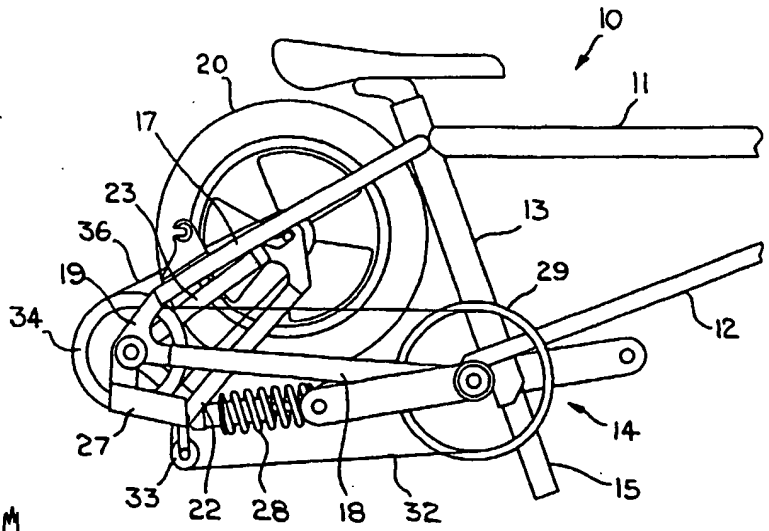

FIG.2

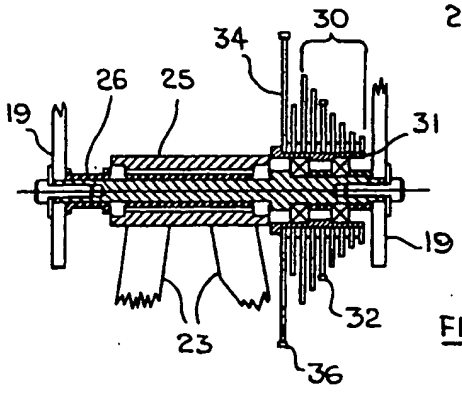

FIG.3

FOLDING BICYCLE

The present invention relates to a small-wheel folding bicycle.

Folding bicycles are popular as transport in urban and other situations when folding into more compact dimensions is of advantage for storage in buildings or for conveyance in other forms of transport, such as rail carriages and motor vehicles. The usual requirement for folding into the smallest size possible is not always compatible with the need for effective use of the bicycle as a means of transport, particularly the need to achieve an acceptable level of speed from the motive force provided by the rider. Translation of the applied motive force into a desired speed of travel requires suitable gearing, which is a function of the diameter of the rear wheel and the speed change ratio between the point of input of the motive force and the point of drive output to the wheel. If larger diameter wheels are used to enhance the translation ratio, this has an adverse effect on the size of the bicycle in the folded state. Conversely, if smaller diameter wheels are used, a large-diameter drive input chainwheel in the usually employed chain-and-sprocket transmission becomes necessary and accommodation of this is compromised by the low ground clearance resulting from the use of small wheels. Moreover, the input chainwheel may itself approach or even exceed the diameter of the rear wheel and thus add a bulky element to the bicycle in its folded state.

For similar reasons it is difficult to use speed change mechanisms, such as derailleur gear systems, in small-wheel bicycles. Gear systems of this kind usually employ a chain displacing device that guides the chain on a downward path and this brings it into the proximity of the ground if the wheel diameter is such as to significantly reduce ground clearance. The constraints imposed by small wheels and other reduced-size components enabling folding into a compact unit also have the consequence that such bicycles usually have suspensions with a short travel and thus provide a less comfortable ride.

It is therefore an object of the present invention to provide a small-wheel folding bicycle which can be free or substantially free of one or more of the mentioned problems associated with bicycles of that kind. Other objects and advantages of the invention will be apparent from the following description.

According to the present invention there is provided a small-wheel folding bicycle including a frame, a swing arm carrying a rear wheel, and a two-stage transmission for transmitting

to the rear wheel motive force applied by a rider of the bicycle, the swing arm being connected with the frame at a junction of the stages of the transmission to be pivotable relative to the frame through a given range of suspension travel and additionally beyond that range for folding the swing arm and wheel relative to the frame to reduce the length of the bicycle.

Through use of a swing arm suspension and two-stage transmission with provision for folding of the swing arm and wheel at the junction of the transmission stages there is created a geometric disposition and relationship of suspension and drive components allowing scope to avoid one or more of the problems associated with small-wheel folding bicycles. The swing arm permits a relatively long suspension travel and the two-stage transmission enables use of a small diameter rear wheel, such as 41 centimetres and less, to optimise the compactness of the bicycle in the folded state, but without obliging use of a large diameter drive input wheel in the transmission. The drive input wheel can, instead, be of an appropriately small diameter and compensation for any loss in gearing to the rear road wheel can be provided at the point of transfer of drive from the input stage to the output stage of the transmission. When folding of the bicycle is required, the location of a folding point at the junction of the transmission stages ensures that the transmission need not hamper the folding procedure. For example, folding can be accompanied by an idling rotation of a chain or chainwheels of the transmission without undue slackening or tightening of the chain. Equally, a change in the length of chain runs does not occur in normal suspension travel of the swing arm.

A further advantage is that the swing arm arrangement, in particular the relationship of the rear wheel to the pivot point of the swing arm, can be selected to provide an anti-bobbing feature. Bobbing arises in bicycles from the influence on the suspension of the power exerted on the pedals and manifests itself as rhythmical compression of the suspension - thus bobbing - in synchronism with the pedal motion. Due to the provision of a trailing swing arm, the reaction of the rear wheel propelling the bicycle forwards can have a lifting effect on the rider. In particular, on the downward power stroke the rear suspension may produce an opposite and almost equal lifting force to largely overcome the bobbing, without the need for any other anti-bobbing measures.

Preferably, the bicycle comprises locking means releasable to permit pivoting of the swing arm beyond the given range of suspension travel. Such locking means can be a quick-action device which, when released, removes a limitation of the pivot motion of the swing

arm to the defined range of suspension travel. The locking means can conveniently be a releasable coupling of suspension spring means to the swing arm or to the frame.

For preference, the effective drive input-to-output length of the input stage of the transmission is greater than that of the output stage of the transmission. If the input stage has a longer effective length than the output stage, preconditions are created for easier accommodation of gearing should this be provided. Preferably, speed change means are located at the junction of the stages and can be arranged so as to take advantage of any increased length of the input stage of the transmission relative to the output stage. Such speed change means can comprise, in the case of a chain-and-sprocket transmission, a plurality of coaxial chainwheels of respectively different diameter. The coaxial chainwheels can be provided by, for example, a standard nine-element chainwheel cassette in which the largest-diameter chainwheel is used for a drive chain of the output stage of the transmission, the adjoining chainwheel is replaced by a spacer and the remaining chainwheels are selectably connectible by a drive chain of the input stage to an input chainwheel of that stage. A derailleur chain displacer for displacing a chain of the transmission, in particular the input stage chain in the described example, can be associated with the speed change means. Such a displacer redirects the chain on which it acts into closer proximity with the ground, but since the two-stage transmission obviates the need for chainwheels of larger than usual size, sufficient ground clearance is preserved.

In addition, or even alternatively, to speed change means at the junction of the transmission stages, a speed change means can be disposed at a drive input of the input stage of the transmission. A speed change means at such a position can take the form of, for example, three individually selectable chainwheels of respectively different diameter. If the two discussed speed change means are both provided, the three chainwheels at the drive input, and seven usable chainwheels at the drive output, of the transmission input stage yield a total of twenty-one different gear ratios, which is considerably in excess of the number of ratios normally possible in a folding bicycle.

Apart from speed change means of the kind employing coaxial chainwheels, the option exists to use other forms of speed change mechanism, such as epicyclic hub gears, if so desired.

For preference, the frame comprises support means extending rearwardly of a drive input point of the input stage of the transmission, the swing arm being connected with the support means at a rearward end thereof. Such a support means can provide a simple extension of a basic frame structure to enable location of the swing arm in a rearward position. The length of the support means rearwardly of the bicycle pedal crank axis, thus the input point of the input stage of the transmission, then largely determines the effective length of that stage. Such support means can comprise two members disposed at a spacing from one another, the rear wheel being partly accommodated in the space between the members when the swing arm and rear wheel are folded. This arrangement contributes to overall compactness of the bicycle in the folded state. The rear wheel can be pivotable forwardly of and under the frame for folding relative thereto, the preferred direction of folding depending on the selected constructional layout.

An embodiment of the present invention will now be more particularly described by way of example with reference to the accompanying drawings, in which:

Fig. 1 is a schematic side view of part of a folding bicycle embodying the invention;

Fig. 2 is a view similar to Fig. 1, but showing the part of the bicycle in folded state; and

Fig. 3 is a cross-sectional view, to enlarged scale, along the line III-III of Fig. 1.

Referring now to the drawings, there is shown part of a small-wheel folding bicycle comprising a frame 10 having, as basic elements, a top tube 11, a down tube 12 and a seat tube 13 together forming an essentially triangular structure. The down tube 12, which comprises two tubular elements (only one visible in the figures) extending at a spacing from each other, and the top tube 11 are connected together by a head tube (not shown) receiving a steering assembly coupled by a front suspension to a front wheel. The down tube 12 and seat tube 13 are connected together by a transverse tube (not shown) receiving an axle of a rotary two-pedal crank drive assembly 14, which can be of conventional form. The seat tube 13 receives a seat post 15 which is retractible into and extensible from the seat tube and lockable in a desired extended setting and which carries a seat.

Projecting rearwardly from the seat tube 13 and forming an extension of the frame 10 is support structure 16 composed of two upper members 17 and two lower members 18. Only one of each of these members is visible in Figs. 1 and 2. The upper members 17 are connected with the seat tube 13 at the point of its connection with the top tube 11 and the lower members 17 are connected with the transverse tube receiving the axle of the drive assembly 14. The two upper members 17 extend divergently from the seat tube 13 so as to be spaced apart at their free ends and each is connected at that end with the free end of a respective one of the lower members 18, which extend in similarly divergent manner. The connection of each member 17 with the associated member 18 is by way of a respective one of two mounting plates 19 extending in spaced-apart parallel planes.

The wheels of the bicycle - only the rear wheel 20 is shown - each consist of an integrally constructed unit with an overall diameter of about 41 centimetres or less. The wheels can, in fact, be of any desired construction and also of greater diameter, but in the context of a folding bicycle the prime objectives are small size and lightness without compromising load-bearing capability. The rear wheel 20 is suspended relative to the frame 10 by a swing arm 21. The swing arm 21 can be of any desired construction and, by way of example only, is shown to be formed in similar manner to the support structure 16, in particular with two first members 22 extending divergently in rearward direction and two second members 23 extending divergently in the same direction, only one first member 22 and one second member 23 being visible in Figs. 1 and 2. Each first member 22 is connected at its rearward end with the rearward end of a respective one of the second members 23 by way of a respective one of two mounting plates 24, which extend in spaced-apart parallel planes and have openings in which an axle of the rear wheel 20 is removably mounted. The second members 23 are connected together at their forward ends by a crosstube 25 rotatably mounted on an axle pin 26 fixed in the two mounting plates 19 of the support structure 16, whereby the swing arm 21 is pivotably connected with the frame 10. The swing arm 21 is completed by a bar 27 connected with and extending between the cross tube 25 and the forward ends of the first members 22 of the swing arm.

Pivotal movement of the swing arm 21 relative to the frame 10 is controlled by a spring and damper unit 28 which is pivotably and detachably connected at one end with mounting brackets on the upper members 17 of the support structure 16 and pivotably connected at the other end with to the forward ends of first members 22 of the swing arm 21. A defined range of suspension travel of the swing arm 21 is determined by, for example, end stops of

the damper part of the unit 28 and/or extension and compression limits of the spring part of that unit.

Transfer of drive from the pedal drive assembly 14 to the rear wheel 20 is provided by a two-stage chain-and-sprocket transmission with an input stage between the assembly 14 and the point of pivotal connection of the swing arm 21 with the frame 10, that is to say the junction of the swing arm and support structure 16, and an output stage between that junction and the axle of the rear wheel 20. The input stage of the transmission is formed by three coaxial drive input chainwheels 29, only one of which is illustrated, of mutually different, graduated diameters mounted on the axle of the drive assembly 14 to be secure against rotation relative thereto, a set of seven coaxial drive output chainwheels 30 of mutually different, graduated diameters mounted on a sleeve 31 to be secure against rotation relative thereto, the sleeve 31 in turn being rotatably mounted by bearings on the axle pin 26, and a first drive chain 32 meshing with a selectable one of the drive input chainwheels 30 and a selectable one of the drive output chainwheels 30. The chain 32 is displaceable between the chainwheels 29 by a first chain displacer (not shown) and between the chainwheels 29 by a derailleur chain displacer 33 which is mounted on a bracket extension of one of the mounting plates 19 and which, as shown in Fig. 1, deflects the chain 32 downwardly an appreciable distance from a direct track between the largest diameter input chainwheel 29 and largest diameter output chainwheel 30. The combination of three selectable drive input chainwheels and seven selectable drive output chainwheels imparts a total of twenty-one gear ratios to the input stage of the transmission.

The output stage of the transmission is formed by a drive input chainwheel 34 mounted on the sleeve 31 to be secure against rotation relative thereto, the chainwheel 34 being spaced from the chainwheels 30 by a spacer disc, a drive output chainwheel 35 mounted on the axle of the rear wheel 20 to be non-rotatable relative to that axle, and a second drive chain 36 permanently meshing with the chainwheels 34 and 35. As is evident from, in particular, Fig. 1, the effective length of the transmission input stage, that is to say the spacing from the axis of the axle of the drive assembly 14 to the axis of the axle 26 at the junction of the transmission stages, is greater than the effective length of the transmission output stage, that is to say the spacing from the axis of the axle 26 to the axis of the rear wheel axle.

The division of the transmission into two stages confers the advantages, in the context of a folding bicycle, of being able to provide a sufficient step-up in rotational speed between the pedal drive assembly 14 and the rear wheel 20 for the purpose of attainment of normal travel speeds on the road without the use of a large diameter road wheel, which would impair the compactness of the bicycle in the folded state, or a large diameter chainwheel, which would have a similar adverse influence on compactness. The scope for achieving the desired transmission speed change results from the provision of at least two sets of input/output chainwheels, but more particularly from the capability of accommodating the components of a full gearing system, including a conventional form of chain displacer having a reducing effect on ground clearance. The layout allows use of standard commercially available chain-and-sprocket and gearing components and is equally able to accept hub-type internal gearing systems.

Apart from the alliance of a compact format with gearing able to provide greater flexibility in travel speeds, the bicycle incorporates a swing arm suspension allowing a sufficient range of suspension travel for effective shock absorption. The coincidence of the swing arm fulcrum with the junction of the transmission stages means that the suspension travel takes place without variation in the lengths of the drive and idle runs of the chains. The trailing arrangement of the swing arm 21 also provides, as previously discussed, an anti-bobbing feature in which the rear wheel reaction, during forward motion, to downward pressure on the pedals of the drive assembly 14 applies a lifting force to the rider so as to tend to cancel bobbing. Moreover, the particular arc through which the rear wheel 20 moves during pivotation of the swing arm can be such that, in the absence of the constraints that might otherwise be imposed by change in chain run length, the wheel is encouraged to move up over bumps by its forward motion, so as to impart additional softness and compliance to the rear suspension.

For folding of the swing arm 21 and rear wheel 20 to reduce the overall length of the bicycle, the connection of the spring and damper unit 28 to the frame can be released at the brackets on the members 17 of the support structure 16, for which purpose the connection can be provided by a quick-release coupling. The swing arm 21 can then be pivoted, beyond its normal range of suspension travel, forwardly and upwardly into the folded position shown in Fig. 2. The spacing of the various members 17, 18 and 22, 23 making up, for the principal part, the support structure 16 and the swing arm 21 can be such that the latter together with the rear wheel 20 can be accommodated partly within the former, which provides a space-saving profile of the rear part of the bicycle in the folded

state. The uncoupled spring and damper unit 28 can be supported by a support device (not shown) provided for that purpose. The process of folding the bicycle includes retraction of the seat post into the seat tube 13 and appropriate folding of the steering assembly and front suspension. Due to the location of the swing arm fulcrum at the junction of the two transmission stages, the pivotation of the swing arm 21 beyond the normal range of suspension travel is permitted by simple rotation of the chainwheels or of the chain 36 around its associated chainwheels without any change in length of the chain runs.

CLAIMS

1. A small-wheel folding bicycle including a frame, a swing arm carrying a rear wheel, and a two-stage transmission for transmitting to the rear wheel motive force applied by a rider of the bicycle, the swing arm being connected with the frame at a junction of the stages of the transmission to be pivotable relative to the frame through a given range of suspension travel and additionally beyond that range for folding the swing arm and wheel relative to the frame to reduce the length of the bicycle.

2. A bicycle as claimed in claim 1, comprising locking means releasable to permit pivoting of the swing arm beyond said range.

3. A bicycle as claimed in claim 2, wherein the locking means comprises a releasable coupling of suspension spring means to the arm or to the frame.

4. A bicycle as claimed in any one of the preceding claims, wherein the effective drive input-to-output length of the input stage of the transmission is greater than that of the output stage of the transmission.

5. A bicycle as claimed in any one of the preceding claims, comprising speed change means located at the junction of the stages.

6. A bicycle as claimed in claim 5, wherein the transmission is a chain-and-sprocket transmission and the speed change means comprises a plurality of coaxial chainwheels of respectively different diameter.

7. A bicycle as claimed in claim 6, comprising a derailleur chain displacer for displacing a chain of the transmission between the coaxial chainwheels.

8. A bicycle as claimed in any one of the preceding claims, comprising speed change means disposed at a drive input of the input stage of the transmission.

9. A bicycle as claimed in any one of the preceding claims, wherein the frame comprises support means extending rearwardly of a drive input point of the input stage of

the transmission, the swing arm being connected with the support means at a rearward end thereof.

10. A bicycle as claimed in claim 9, wherein the support means comprises two members disposed at a spacing from one another, the rear wheel being partly accommodated in the space between the members when the swing arm and rear wheel are folded.

11. A bicycle as claimed in claim 9 or claim 10, wherein the rear wheel is pivotable forwardly of and under the frame for folding relative thereto.

The Patent Office
PATENTS • DESIGNS • COPYRIGHT • TRADE MARKS
INVESTOR IN PEOPLE

Application No: GB 0108063.9 **Examiner:** Roger Binding
Claims searched: 1-11 **Date of search:** 3 July 2001

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.S): B7E (ECF, EDTX)

Int Cl (Ed.7): B62K 15/00

Other: Online WPI EPODOC JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
Y	GB 2260520 A	(EUROPEAN RESEARCH), see page 6, line 21, to page 7, line 12.	1, 8, 9
Y	EP 0965517 A2	(BMW), see the embodiment of Figs 3 & 4.	1-3
Y	WO 99/38759 A1	(BELLI), see the Figs.	1, 2, 9, 11
Y	DE 4313832 A	(RIESE)	1, 2

X Document indicating lack of novelty or inventive step
Y Document indicating lack of inventive step if combined with one or more other documents of same category.
& Member of the same patent family
A Document indicating technological background and/or state of the art.
P Document published on or after the declared priority date but before the filing date of this invention.
E Patent document published on or after, but with priority date earlier than, the filing date of this application.